AbstractID: 3739 Title: IMRT planning based on various photon dose calculation techniques at inhomogeneous media

Purpose: An EGSnrc-based Monte Carlo dose calculation tool was established to optimize fluence levels of intensity-modulated treatment fields. It was used to benchmark dose distributions in inhomogeneous human regions optimized with a superposition as well as a standard pencil beam algorithm in order to quantify the applicability of the dose calculation engines even during the optimization process.

Method and Materials: An EGSnrc-based Monte Carlo dose calculation tool and a previously implemented superposition dose engine were adapted to a derivative of the inverse planning tool KonRad in order to iteratively optimize fluence patterns. BEAMnrc was applied to simulate 6MV and 15MV Siemens Primus accelerators. The acquired phase space information was input to a newly generated two-source photon/electron beam model. Excellent congruence between Monte Carlo simulations and dose measurements was achieved for homogeneous and inhomogeneous phantoms.

Results: Using Monte Carlo as benchmark, the systematic and convergence error of a pencil beam and the superposition dose engine for five IMRT treatments of clinical lung and five head&neck cases were ascertained. The pencil beam overestimated the prescribed PTV dose up to 16.7%, severe deficiencies were even detected in respect to the convergence error. For the head&neck cases a significant overestimation of dose deposited at tumor-air-intersections was observed.
The superposition algorithm mostly generates acceptable results apart from intricate lung cases, where the dose still was overestimated by up to 6%.

Conclusion: Applying highly-sophisticated dose engines as superposition or Monte Carlo yields reliable dose information for IMRT-planning in target regions with intricate tissue inhomogeneities. Our studies showed, that in such regions superposition or Monte Carlo techniques have to be used for the optimization and the final dose calculation of intensity-modulated treatment plans, since standard pencil beam algorithms both lead to inappropriate fluence levels during the optimization and wrongly calculate the dose.